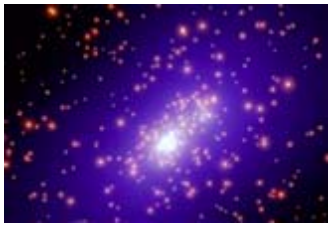

Dark Matter Investigation Maps the Invisible

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Astronomers cannot see most of the matter in the universe, but now they have a map showing how this mysterious "dark matter" is distributed through a large cluster of galaxies.

Dark matter comprises about 85 percent of all the stuff in the cosmos. It can't be seen, but scientists know it is there because its gravity is needed to explain how galaxies are held together.

To get a better handle on dark matter, researchers have now mapped a chunk of it by studying the way its gravity bends light from more distant objects, a technique called gravitational lensing.

The result, announced Thursday, confirms one important expectation about the unseen material: Its density drops sharply with the distance from the center of a galaxy cluster. These clusters are the largest structures in the universe, employing gravity to bind many galaxies together.

"Although theorists have predicted the form of dark matter in galaxy clusters from numerical simulations based on the effects of gravity alone, this is the first time we have convincing observations to back them up," said Richard Ellis of Caltech. "Some astronomers had speculated clusters might contain large reservoirs of dark matter in their outermost regions. Assuming our cluster is representative, this is not the case."

Still, nobody knows what dark matter actually is. Theorists figure is plays a crucial role in galaxy birth and development, however.

The cluster, examined with the Hubble Space Telescope, is 4.5 billion light-years away. Even at that great distance, viewed from Earth it covers an area of the sky equal to the full Moon. An unusual 120 hours of Hubble time were consumed to collect the data on light coming from even more distant galaxies and passing through the cluster.

The resulting map covers a region of space that extends 15 million light-years from the cluster center. The study will be detailed in the *Astrophysical Journal*.

The observations proved out another theorized trait of dark matter: It is concentrated around galaxies that are falling into

Images

Dark matter map shows how the mystery stuff clumps with galaxies. Blue regions represent inferred dark matter. Red indicates direct observations of visible galaxies.

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the cluster, known as CL0024+1654.

Jean-Paul Kneib, who led the work, said it shows dark matter does indeed serve as galactic glue.

"The close association of dark matter with structure in the galaxy distribution is convincing evidence that clusters like the one studied built up from the merging of smaller groups of galaxies, which were prevented from flying away by the gravitational pull of their dark matter," said Kneib, of Caltech and the Observatoire Midi-Pyrénées.

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Further study of other clusters will be needed to confirm the results, the researchers said.

Hubble is a joint project of NASA and the European Space Agency.

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